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In the course of a bubble chamber investigation of the interaction of low-energy K^- mesons in hydrogen, we have observed forty-five reactions of the type $K^- + p \rightarrow \bar{K}^0 + n$ followed by the observable decay $K_1 \rightarrow \pi^+ + \pi^-$.[1]

Experimental Discussion: The only other type of event which could be confused with the observed type is the much more frequent sequence $K^- + p \rightarrow \Lambda + \pi^0$, $\Lambda \rightarrow p + \pi^-$. However in Λ decay, the proton usually stops, but if it does not, its greater ionization generally permits identification. In order to certify the identification, all V's in which the positive decay product did not stop in the chamber were measured and fitted to both the Λ and K_1 interpretations. All events fitted one or the other--there were no ambiguities.

The calculated momentum of the K^- at the point of interaction P_{K^-} depends sensitively on the K^--$\bar{K}^0$ mass excess, which has been measured in this and other experiments to be 3.9 ± 0.6 Mev.[2] The threshold for charge exchange is then 89 ± 5 Mev/c.

For each event, P_{K^-} was adjusted to give a simultaneous best fit to the production kinematics, by the use of the momentum of the K^- (computed from its decay kinematics), the curvature of the K^-, and the known momentum distribution of the K^- beam. The cross section below 300 Mev/c was then obtained

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by constructing an ideogram which gave the fraction of events in each of the four momentum intervals below 300 Mev/c shown in Fig. 1.

Data were also taken with the beam momentum adjusted for 310 ± 22 Mev/c and 410 ± 15 Mev/c. Even at these higher momenta the K^- velocity is low enough that ionization can be used to distinguish K^- from μ^- and π^- contamination in the beam.

The fraction of K^0 decaying by the $\pi^+ + \pi^-$ mode was taken to be 0.34 ± 0.02.[3]

Results: The K^0_1 mean life obtained from these events is $0.87 \pm 0.13 \times 10^{-10}$ sec., in agreement with other experiments.[4]

Figure 1 shows the cross section as a function of K^- laboratory momentum. The solid curve represents the charge-exchange cross section as evaluated from the S-wave, zero-effective range approximation,[5] which fits the data satisfactorily. The dashed curve is the charge-exchange cross section (with arbitrary ordinate) predicted by Pais[6] in his theory embodying opposite parities for charged and neutral K's. There is in this theory a free parameter λ which can range from -1 (the prediction of perturbation theory) to +1. We have plotted $\lambda = -1$ as being the theoretically simplest choice (it also fits the data best). It can be seen that our data are inadequate to distinguish between the two curves. Both curves have been modified to take into account the mass-differences. For the effective range theory this was done simply by the introduction of a factor $p_{final}/v_{initial}$ into the cross sections. These effects dominate near threshold and tend to obscure the swift p^2 rise which would otherwise be characteristic of the Pais theory.

Figure 2 shows the angular distribution as a function of momentum. The S-wave effective-range theory predicts, of course, isotropy. The dashed curve is the Pais prediction from $\lambda = -1$, $P_K = 180$ Mev/c. Chi-squared tests on the experimental angular distribution show a probability of about 5% associated with either the isotropic or Pais hypotheses.

We wish to thank Professors R. Dalitz, A. Pais, and J.D. Jackson for illuminating discussions and Professor Luis Alvarez and other members of the hydrogen bubble chamber group for their interest and cooperation.

FOOTNOTES

[1] Preliminary cross sections for elastic scattering and hyperon production channels are given in the report of the 1958 Annual International Conference on High-Energy Physics at CERN (CERN, Geneva, 1958), and in Bull. Am. Phys. Soc. 3, 336 and 363 (1958), and ibid. 4, 24 (1959); data analysis is continuing. The electrostatically separated beam is described by Horwitz, Murray, Ross, and Tripp, in "450-Mev/c K^- and $\overline{p}$ Beams at the Northwest Target Area of the Bevatron Separated by the Coaxial Velocity Spectrometer", UCRL-8629, June 1958.

[2] Rosenfeld, Solmitz, and Tripp, Phys. Rev. Lett. 2, 110 (1959); Crawford, Cresti, Good, Stevenson, and Ticho, Phys. Rev. Lett. 2, 112 (1959).

[3] Crawford, Cresti, Douglass, Good, Kalbfleisch, Stevenson, and Ticho, Phys. Rev. Lett. (to be published, 1959).

[4] [illegible]. D. Glaser, 1958 Annual International Conference on High Energy Physics at CERN (CERN, Geneva, 1958), p. 272.

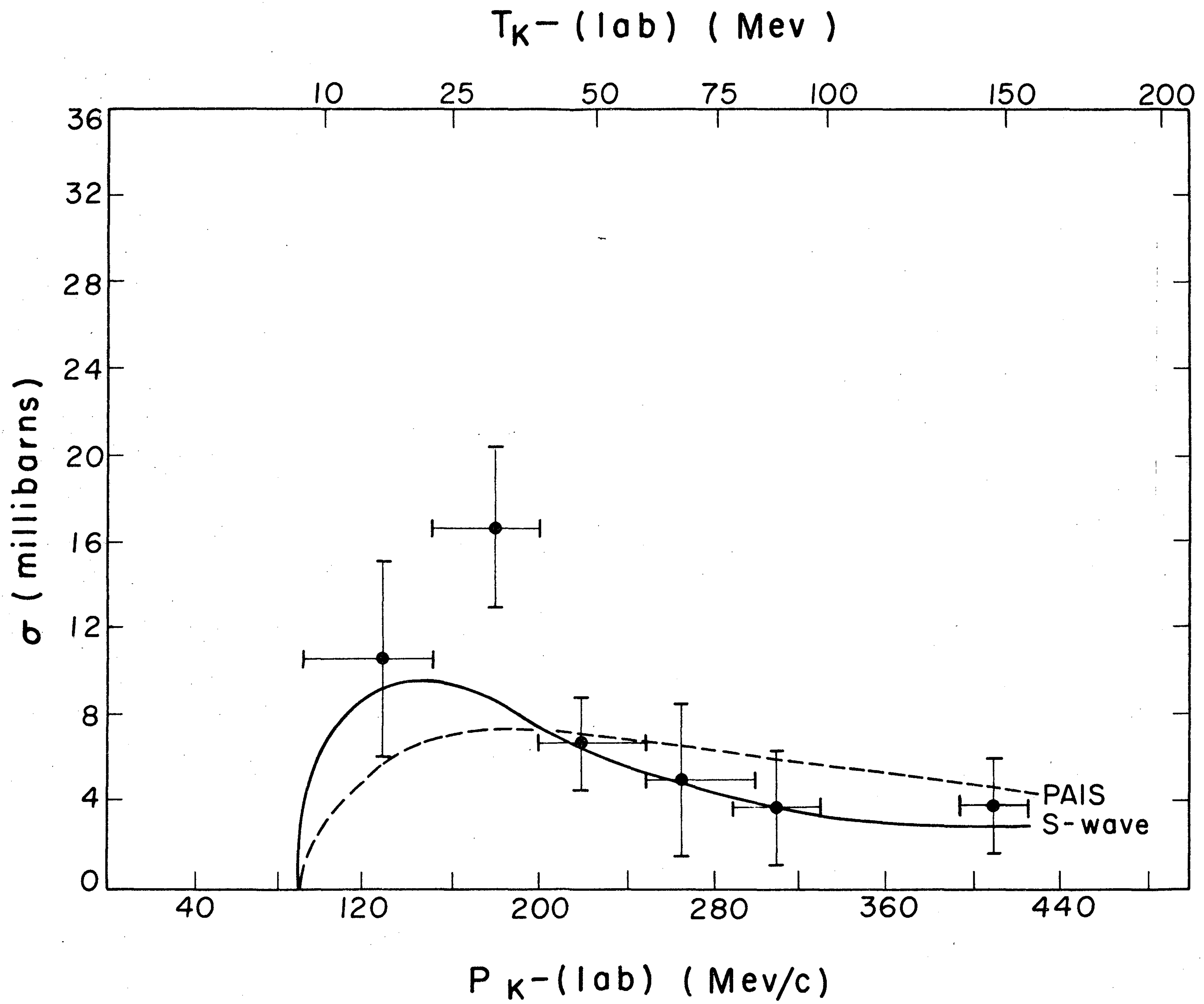
[5] Jackson, Ravenhall, and Wyld, Nuovo cimento 10, 834 (1958). At the 1958 Geneva Conference, R.H. Dalitz[1] used this approximation to make an experimental fit, largely based on our very preliminary data. We have still not completed the analysis of all our data, but at present it appears that the cross sections for elastic scattering and charged Σ production are larger by about 25% and 15% respectively than the values used by Dalitz.

[6] A. Pais, Phys. Rev. 112, 624 (1958).

Figure legends

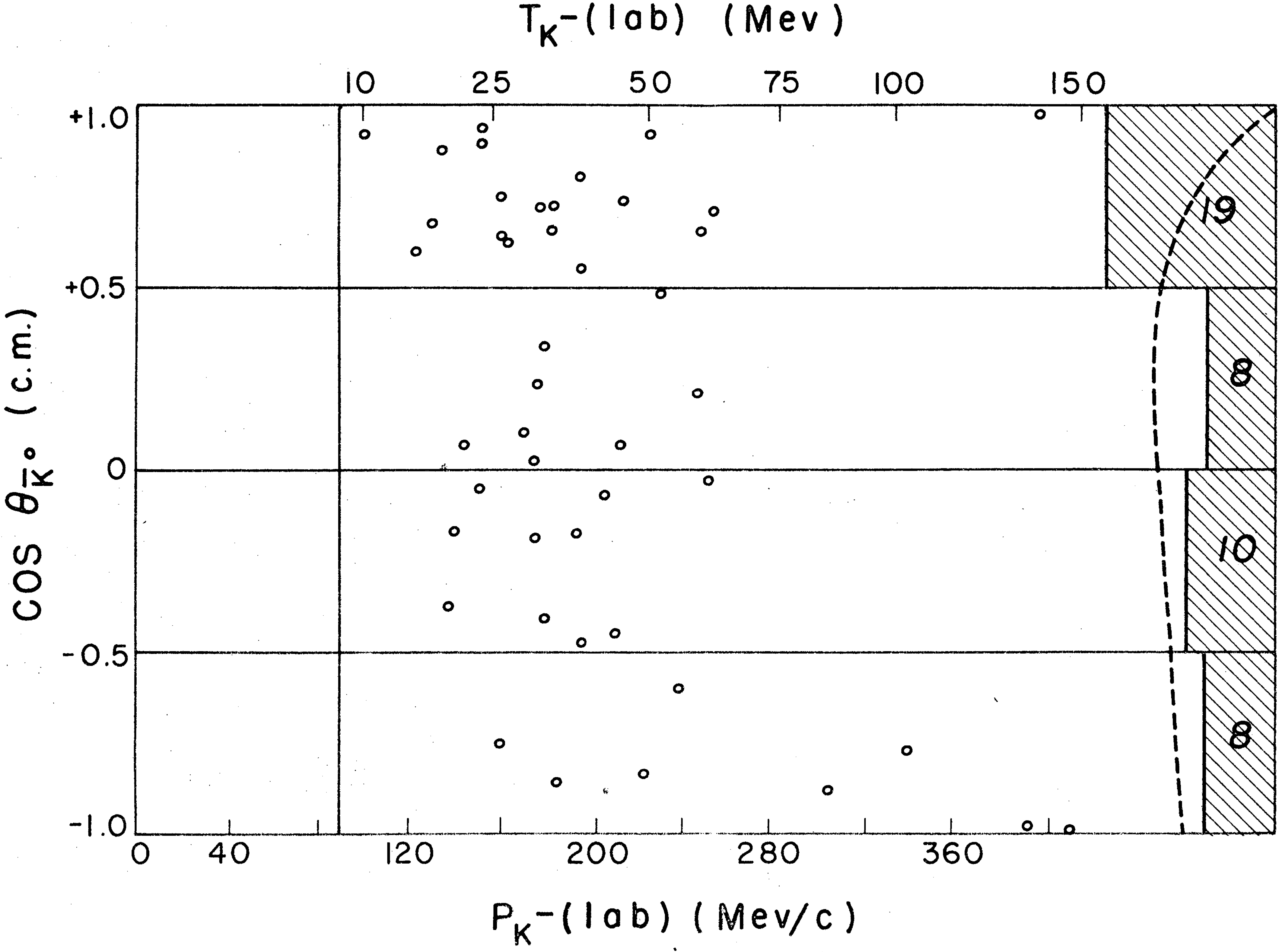
Fig. 1. K^--hydrogen charge-exchange cross section vs. K^- laboratory momentum. The solid curve is the prediction of the S-wave zero-effective-range theory. The dashed curve (arbitrary ordinate) is the prediction of the Pais theory with $\lambda = -1$.

Fig. 2. Angular distribution of K^--hydrogen charge-exchange scattering vs. K^- laboratory momentum. Each dot represents an event. A histogram appears at the right. The curve represents the prediction of the Pais theory for $\lambda = -1$ at a momentum of 180 Mev/c.



TK− (lab) (Mev)
10
25
50
75
100
150
200
σ (millibarns)
0
4
8
12
16
20
24
28
32
36
PAIS
S-wave
40
120
200
280
360
440
P K−(lab) (Mev/c)

Fig. 1
55,223-2



T_{K^-}(lab) (Mev)
10
25
50
75
100
150
+1.0
+0.5
0
-0.5
-1.0
COS $\theta_{\bar{K}^\circ}$ (c.m.)
19
8
10
8
0
40
120
200
280
360
P_{K^-}(lab) (Mev/c)

Fig. 2
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